

**WHAT IS CLAIMED IS:**

- 1     1.     A hardware-reconfigurable digital filter having multiple filtering modes,  
2     comprising:  
3         logic circuitry adapted to process data corresponding to input data, the logic  
4     circuitry including an X-by-Y array of registers for supporting at least one first filtering  
5     mode using the registers arranged linearly and for supporting at least one second  
6     filtering mode using the registers arranged nonlinearly, wherein each of X and Y is at  
7     least 2;  
8         computational circuitry adapted to perform computations responsive to the logic  
9     circuitry and including at least Y multiplication logic circuits and at least Y addition  
10    logic circuits; and  
11         mode selection circuitry adapted to switch the digital filter between the multiple  
12    filtering modes.
- 1     2.     The hardware-reconfigurable digital filter of claim 1, wherein the logic circuitry  
2     and the computational circuit are configurable, in response to the mode selection  
3     circuitry, to operate in at least two of the following filtering modes: polyphase direct,  
4     polyphase transposed, finite-impulse response 11-tap, and finite-impulse response 12-  
5     tap.
- 1     3.     The hardware-reconfigurable digital filter of claim 1, wherein each of the  
2     multiplication and addition logic circuits along a Y-axis direction has reconfiguration  
3     circuitry adapted to reconfigure the multiplication and addition logic circuits along the  
4     Y-axis direction the logic circuitry in response to the mode selection circuitry,  
5     and the first filtering mode supports an impulse response filtering mode and the second  
6     filtering mode supports at one polyphase filtering mode and another impulse response  
7     filtering mode.

1 4. The hardware-reconfigurable digital filter of claim 1, wherein the logic circuitry  
2 and the computational circuitry are configurable to operate in one of the following  
3 filtering modes: a polyphase direct filtering mode, a polyphase transposed filtering  
4 mode, and a FIR filtering mode.

1 5. The hardware-reconfigurable digital filter of claim 4, wherein the mode selection  
2 circuitry adapted to switch the digital filter between the polyphase transposed filtering  
3 mode and another one of the modes.

1 6. The hardware-reconfigurable digital filter of claim 5, wherein the mode selection  
2 circuitry includes a first selection circuit adapted to switch the digital filter into the  
3 polyphase transposed filtering mode, and a second selection circuit adapted to switch  
4 the digital filter between modes other than the polyphase transposed filtering mode.

1 7. The hardware-reconfigurable digital filter of claim 6, wherein the first selection  
2 circuit is adapted to reconfigure the computational circuitry, and the second selection  
3 circuit is adapted to reconfigure the logic circuitry.

1 8. The hardware-reconfigurable digital filter of claim 6, wherein the modes other  
2 than the polyphase transposed filtering mode include a polyphase direct filtering mode,  
3 and two FIR filtering modes, one of the FIR filtering modes including more taps than  
4 the other of the two FIR filtering modes.

1 9. The hardware-reconfigurable digital filter of claim 1, wherein the logic circuitry  
2 and the computational circuit are configurable to support saving and loading video data  
3 for context switching and switching back and forth among multiple long input lines.

1 10. The hardware-reconfigurable digital filter of claim 1, wherein a plurality of the  
2 registers in the array is adapted as sliced circuits along an axis defined by an alignment  
3 of the Y registers.

1 11. The hardware-reconfigurable digital filter of claim 1, wherein each of a first  
2 plurality of the registers in the array is adapted as a first sliced circuit along an axis  
3 defined by an alignment of the Y registers, and each of a second plurality of the  
4 registers in the array is adapted as a second sliced circuit along an axis defined by an  
5 alignment of the Y registers.

1 12. A hardware-reconfigurable digital filter having multiple filtering modes,  
2 comprising:  
3 logic circuitry adapted to process and mirror data corresponding to filter inputs  
4 about a data point corresponding to selected target node in a video image segment, the  
5 logic circuitry including an X-by-Y array of registers, wherein Y is greater than X and  
6 X is at least 2;  
7 a computational circuit adapted to perform computations responsive to the logic  
8 circuitry and including at least Y multiplication logic circuits and at least Y addition  
9 logic circuit; and  
10 mode selection circuitry adapted to direct the digital filter into a polyphase  
11 transposed filtering mode by configuring the logic circuitry and the computational  
12 circuitry for processing data using the registers in a linear array and to direct the digital  
13 filter into another filtering mode by configuring the logic circuitry and the  
14 computational circuitry for processing data using the registers in a nonlinear array.

1 13. The hardware-reconfigurable digital filter of claim 12, wherein a plurality of the  
2 registers in the array is adapted as sliced circuits.

1 14. The hardware-reconfigurable digital filter of claim 12, wherein a plurality of the  
2 registers in the array is adapted as sliced circuits along an axis defined by an alignment  
3 of the Y registers.

1 15. The hardware-reconfigurable digital filter of claim 12, wherein each of a first  
2 plurality of the registers in the array is adapted as a first sliced circuit along an axis

3 defined by an alignment of the Y registers, and each of a second plurality of the  
4 registers in the array is adapted as a second sliced circuit along an axis defined by an  
5 alignment of the Y registers.

1 16. The hardware-reconfigurable digital filter of claim 12, wherein X is equal to two  
2 and Y is not less than 6, and wherein the multiple filtering modes include the polyphase  
3 transposed filtering mode, a polyphase direct filtering mode, and two FIR filtering  
4 modes, one of the FIR filtering modes including more taps than the other of the two FIR  
5 filtering modes.

1 17. The hardware-reconfigurable digital filter of claim 16, wherein one of the FIR  
2 filtering modes includes 12 taps.

1 18. A hardware-reconfigurable digital filter having multiple filtering modes,  
2 comprising:  
3 logic means for processing data corresponding to input data, the logic means  
4 including an X-by-Y array of registers for supporting at least one first filtering mode  
5 using the registers arranged linearly and for supporting at least one second filtering  
6 mode using the registers arranged nonlinearly, wherein each of X and Y is at least 2;  
7 selection means adapted to switch the digital filter between different ones of the  
8 multiple filtering modes; and  
9 computational means adapted to perform computations responsive to the logic  
10 means and including at least Y multiplication logic circuits and at least Y addition logic  
11 circuits.

1 19. A hardware-reconfigurable digital filter having multiple filtering modes,  
2 comprising:  
3 logic means for processing and mirroring data corresponding to filter inputs  
4 about a data point corresponding to selected target node in a video image segment, the  
5 logic circuitry including an X-by-Y array of registers for supporting at least one first

6 filtering mode using the registers arranged linearly and for supporting at least one  
7 second filtering mode using the registers arranged nonlinearly, wherein Y is greater than  
8 X and X is at least 2;

9 means for switching the digital filter between a polyphase transposed filtering  
10 mode and at least one other mode of the multiple filtering modes; and

11 means for performing computations responsive to the logic means and including  
12 at least Y multiplication logic circuits and at least Y addition logic circuits, each of the  
13 multiplication and addition logic circuits having reconfiguration means responsive to  
14 the switching means.

1 20. The hardware-reconfigurable digital filter of claim 19, wherein sets of the Y  
2 multiplication logic circuits and Y addition logic circuits are sliced circuits.

1 21. A hardware-reconfigurable digital filter having multiple filtering modes,  
2 comprising:

3 logic circuitry adapted to process data corresponding to input data, the logic  
4 circuitry including a 2-by-6 array of registers for supporting a 12-tap FIR filtering mode  
5 using the registers arranged linearly and, using the registers arranged nonlinearly, for  
6 supporting an 11-tap FIR filtering mode in which two of the registers at an end of the  
7 array are paired, a polyphase direct filtering mode in which each of six pairs of the  
8 registers is used to combine a single input to the pair, and polyphase transposed filtering  
9 mode in which six pairs of the registers are used to provide a wide bitwidth  
10 corresponding to a high-precision number;

11 computational circuitry adapted to perform computations responsive to the logic  
12 circuitry and including a multiplication logic circuit and an addition logic circuit,  
13 separately arranged, for receiving and processing data from each of the six pairs of  
14 registers; and

15 mode selection circuitry adapted to switch the digital filter between the multiple  
16 filtering modes.